IJAS Iranian Journal of Applied Animal Science

Investigating the Setbacks in Conventional Dairy Farms by the Follow-Up of Their Potential and Effective Milk Yields

Research Article

M.T. Srairi[1*], Y. Sannito[1] and J.F. Tourrand[2]

[1] Department of Animal Production and Biotechnology, Hassan II Agronomy and Veterinary Medicine Institute, Madinate Al Irfane, 10 101, Rabat, Morocco
[2] Department of Animal Production, CIRAD Environnement et Societes, Campus International de Baillarguet, TA30 / A, 34 398 Montpellier Cedex 5, Montpellier, France

Received on: 23 Feb 2014
Revised on: 5 Aug 2014
Accepted on: 14 Aug 2014
Online Published on: Jun 2015

*Correspondence E-mail: mt.srairi@iav.ac.ma

Online version is available on: www.ijas.ir

ABSTRACT

The present study investigates the gap between the daily milk production potential and the effective milk yields in six herds. These two parameters and their changes were observed in the Gharb irrigation scheme (northwest of Morocco), during a five months study period. They were analyzed in relation to the changes in the rations of the cows and in their live weights. Results reveal that under conventional cattle rearing conditions in Morocco, i.e. the vast majority of smallholder units and farms with an area less than 20 ha, dairy production suffers from numerous setbacks. One of the most evident is farmer's lack of knowledge of cows' dietary requirements and their changes throughout the lactation period. Moreover, dairy farmers seem to ignore the changes in forages net energy, rumen degradable and metabolizable protein contents, which induce many errors in providing concentrate supplements. Results also show that the effective milk yield is often inferior to the lactation potential, given the limited availability of forage coupled to errors in rations formulation. Finally, the results emphasize the need to reconsider the use of high genetic merit cows, because of their rising prices, in farms characterized by erratic fodder availability coupled to the absence of balanced rations formulation.

KEY WORDS dairy herds, effective milk yield, lactation potential, live weight, rations.

INTRODUCTION

In many developing countries, a wide diversity of farms, of which numerous smallholder units, assume a vital role of supplying milk to processing plants (Bernard *et al.* 2011). In this context, many setbacks however characterize cattle farms performances, because of unadapted practises (Mc Dermott *et al.* 2010). Moreover, the disengagement of traditional state extension services has led many farms without any kind of advice (Kidd *et al.* 2000). Although there is some support from the private sector, and some farmers try to tackle the lack of technical know-how by the promotion of peer-to peer learning processes within dairy collection co-operatives (Faysse *et al.* 2012), many studies confirmed a limited milk yield in comparison to the genetic potential of the cows (Moran, 2013; Srairi *et al.* 2009). In Morocco, smallholder units, less than 5 cows on an arable area not exceeding 5 ha, and farms with less than 20 ha account for more than 95% of the 700000 cattle farms. Dairying represents a key activity to ensure the supply of food proteins to a fast growing urban population. It was encouraged by public policies through the settlement of high genetic merit herds (mainly Holstein and Montbeliarde breeds), with some 380000 heifers imported from 1970 to 2011 (ADA, 2011). Dairying in Morocco is however hindered by climatic difficulties within the majority of the areas of the country, characterized by a semiarid or an arid climate, which imply an increased use of concentrates (Srairi and El Khattabi, 2001). The fragmented structure of the supply makes it impossible to get a precise picture about the on-farm practices: from the fodder biomass output to its conversion to cattle products, i.e. milk and meat. In fact, the vast majority of herds are dual purpose and there is a competition of these two products on the dietary nutrients available (Le Gal *et al*. 2009). Cattle farms have to cope throughout the year with the changes in the reproductive status of the herd and in fodder nutrients values (net energy and protein) and the possibilities to supplement concentrates to enhance the diets nutritive value (Wanapat, 2009). Because of the numerous farms involved in cattle rearing and due to the numbers of variables required to determine their actual performance, it is impossible to elaborate a precise diagnosis of herds milk yield. Therefore, this article aims to draw light on the determinants of dairy production within smallholder units. To achieve that goal, a series of visits of farms located in an irrigation scheme were conducted, throughout a period of five months. First, the herd's reproductive status and their changes were monitored to determine their lactation potential. Then, the effective average milk yield per cow was assessed during the study period. Finally, the nutrient contents of the diets were determined and the cows weights were monitored.

MATERIALS AND METHODS

Context

The study was undertaken in the Gharb irrigation scheme (Figure 1). Located in the north western part of Morocco, this site is one of the most favourable for agricultural intensification in the country, given its mean annual level of rainfall above 500 mm and its fertile soils. The Gharb irrigation scheme has therefore been identified as a strategic spot for the increase of the dairy output within the ongoing agricultural policies, called the “Green Morocco Plan”, as the annual milk volumes are expected to rise from 280 to 1,100 thousand tons, from 2008 to 2020 (ADA, 2011).

Study sample and methodology

Six farms were chosen in collaboration with the local representation of the National Cattle Breeders Association in Morocco. The main objective of such a sample study was to provide farms representing the wide diversity of cattle rearing situations which can be found in the Gharb irrigation scheme (Srairi *et al*. 2003): three smallholder farms (arable area less than 5 ha) and three bigger farms and with diverse fodder crops (mainly berseem *Trifolium alexandrinum* but also alfalfa and maize silage). Herds consisted of cows of variable genetic merit, mainly purebred Holstein but also cross of Holstein cows with local breeds. The main structural characteristics of the six farms are reported in Table 1.

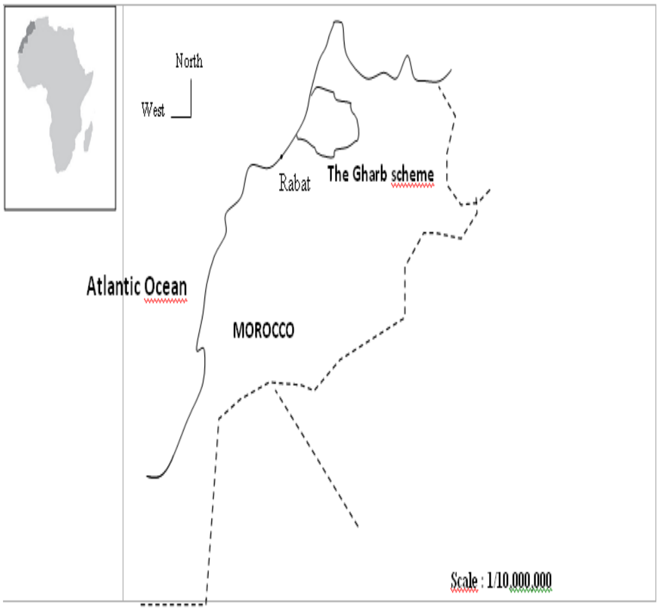

Figure 1 Localization of the study region: the Gharb large scale irrigation scheme

In each farm, an initial survey coupled with the observation of the herd and fodder crops' plots was conducted in the beginning of March 2013. Milking cows reproductive status (i.e. dates of calving) was determined throughout the study period. Then, the follow-up of farms begun with a single monthly visit, from March to July 2013, following the protocol of the international animal recording standards (ICAR, 2011). During this monthly visit, the average milk yield per lactating cow was determined and its relationship to the herd's average lactating stage was studied. The latter indicator was calculated by equation (1):

$$\text{Lactation stage}_j = \Sigma \text{ lactation duration}_{k,j} / (\text{total milked cows}_j \times 30.4) \quad (1)$$

With:
Lactation stage$_j$.
Lactation stage (in months) for month *j*.
Lactation duration$_{k,j}$.
Number of milking days from calving for cow *k* and month *j*.
Total milked cows$_j$.
Total number of milked cows for month *j*.

The herd's average lactating stage was converted to a potential daily milk yield, by the use of the models established by Wilmink (1987), which link the daily milk potential to genetic merit and the physiological status of the cows, i.e. number of days of lactation after calving.

Table 1 Structural characteristics of the sample study farms

	Fodder area (ha)			Cereals' area (ha)	Lactating cows	Milk potential (kg/year)
	Berseem	Maize	Alfalfa			
Farm 1	10.0	30.0	-	70.0	20	6000
Farm 2	13	-	-	3.2	3	8000
Farm 3	5.0	5.0	3.0	12.0	15	5000
Farm 4	7.0	-	-	2.5	6	6000
Farm 5	7.0	-	-	2.0	6	6500
Farm 6	28.0	-	-	7.0	7	7000

For that purpose, we considered that purebred imported Holstein cows have an annual potential of 8000 kg of milk per year and crossbred cows (local×Holstein breeds) a potential of 3000 kg of milk annually. In herds with a composite structure (i.e. cows of different breeds, like both purebred Holstein and crossbred Holstein×local cows), the average genetic merit was determined according to the number of cows and their respective potential. Furthermore, during each visit, cows live weight was estimated by the heart girth method according to the following formula (Heinrichs *et al.* 2007):

$$LW = 15.7 + (66.88 \times HG^3)$$

Where:
LW: live weight (kg).
HG: heart girth (m).

This allowed getting a precise knowledge of cow's nutrient requirements for both net energy and proteins for maintenance (Jarrige, 1988) and to estimate cows live weight gain or loss as a variable closely linked to the herd's nutritional balance. For that purpose, the rations effectively ingested by cows during the visit day were observed. As all the farms adopted a "zero grazing" system due to limited fodder areas, the distributed feeds were weighted. The biomass output from neighbouring fodder plots was determined through the quadrate method, with three replicates at each cut (Martin *et al.* 2005). The supplement feed concentrates were weighted at the barn. The overall rations effectively ingested by cows (both fodder and feed concentrates) were assessed for their nutrients content: net energy, rumen degradable protein (RDP) and metabolizable protein (MP). The two latter parameters related to the protein status of the diet were determined according to the French system of the proteines digestibles dans l'intestin (PDI)-(Verite and Peyraud, 1988). The nutritive contents of the rations were determined using feed composition tables. For concentrates, which were mainly imported, the INRA France table was used (Jarrige, 1988), whereas for local fodder (fresh berseem, berseem hay, alfalfa, maize silage, oat hay and wheat straw), the average dry matter (DM) content for the existing forages were adopted from Guessous (1991): fresh berseem (9.2%), berseem hay (85.1%), alfalfa (24.1%), maize silage (28.3%), oat hay (87.9%) and wheat straw (88.1%). Their net energy, RDP and MP contents per kg of DM were as follow: fresh berseem (1.44 Mcal, 131 and 100 g), berseem hay (1.10 Mcal, 135 and 106 g), alfalfa (1.38 Mcal, 162 and 137 g), maize silage (1.38 Mcal, 46 and 57 g), oat hay (1.25 Mcal, 51 and 66 g) and wheat straw (0.8 Mcal, 25 and 53 g). The net energy, RDP and MP contents per kg of DM for the available concentrates used during the farms observations were: barley grain (2.02 Mcal, 84 and 113 g), dried beet pulp (1.87 Mcal, 68 and 91 g), rice bran (1.57 Mcal, 104 and 96 g) and wheat bran (1.43 Mcal, 112 and 104 g).

In addition to these feedstuffs, some farmers purchased compound feeds made especially for dairy production. These were processed by the feed industry to allow a production of 2 kg of milk per single kg of compound feed used, whenever forages nutrients availability was sufficient to cover net energy and requirements needs. Their mean nutritive values were therefore calculated as follows: 1.5 Mcal and 96 g of protein (RDP or MP). At the end of each farm monthly visit, the effective ingested nutrients were compared to the cow's maintenance requirements. It was assumed that whenever maintenance requirements were fulfilled (i.e. 9.0 Mcal of net energy for a 620 kg Holstein cow and 420 g of proteins, either RDP and MP), the remaining nutrients would be used to cover dairy production, as a single kg of milk requires 0.76 Mcal and 48 g of proteins -either RDP and MP- (Verite and Peyraud, 1988).

Nutrients excesses or insufficiencies for both energy, RDP or MP were assessed. Their effects on live weight gain (in case of excess energy in comparison to proteins) and/or milk losses (unbalanced rations) were characterized for the duration of the whole follow-up. The gap between both potential and effective milk yields was characterized and explained either by feeding insufficiencies or unbalances.

RESULTS AND DISCUSSION

Farms' structural characteristics and lactation genetic potential

The mean arable area for the six study farms was 37.2 ± 42.3 ha, illustrating a wide diversity of sizes, from smallholder units to bigger farms.

The available fodder crops were mainly berseem, with a mean 9.7 ± 9.2 ha in the six farms, followed by maize (available in only two farms, respectively 30 and 5 ha) and alfalfa (3 ha in only one farm). In addition to these crops, farmers relied on previously cut roughages as a source of fibre for their herds, particularly at the beginning of summer, when the berseem production ceases. These roughages were mainly wheat straw and oat hay. The average lactating cows number of the six farms was 9.5 ± 6.5, inducing a load of 0.6 cows and their progeny per ha of fodder (Table 1). Lactating cows genetic merit varied among farms, from a minimal value of 5000 kg per cow in a composite herd, as in farm 3, to 8000 kg in recently imported purebred herds (Holstein cows, as in farm 2). The wide variations in farms characteristics induced diverse strategies in cattle rearing styles and imply difficulties to analyse the determinants of their performances. Moreover, two farms (1 and 3) did not rely on a single fodder crop (i.e. berseem). Therefore the remaining four farms face marked difficulties to feed the cows with a good quality source of roughages at the end of berseem, as a winter crop, availability.

The average daily lactation potential and its comparison with the effective milk yield

The observations revealed a mean effective daily milk yield of 15.4 ± 3.4 kg per cow (Table 2). This value was largely inferior to the potential of daily milk production, which was estimated at a mean value of 20.4 ± 2.5 kg per cow. An average deficit of almost 5 kg of milk per cow per day could be noticed. These values correspond to various types of dairy production setbacks. It seems that the average daily milk yields per cow were higher in farms with a limited number of females (as in farms 2, 4 and 5 with less than 6 cows, where they reached 17.2, 15.5 and 19.7 kg, respectively) in comparison with bigger herds (from 9 to 20, in farms 1, 3 and 6 in which the average daily milk yield per cow was 11.5, 13.0 and 15.3 kg). This may be related to limited fodder availability in farms with important numbers of cattle. In all the farms, there is a trend of a decrease in the average milk yield at the end of spring, particularly with the end of berseem availability and its substitution by either wheat straw or lignified berseem hay.

A characterization of the gaps between the daily lactation potential and the effective milk yield

Three main kinds of gaps between the herd's average daily lactation potential and its effective mean milk yield were distinguished.

In the first case, as illustrated by farms 1 and 5, there is a constant difference between the two indicators. For example, in farm 1, in which the herd's potential was estimated to be 6000 kg of milk yearly, the effective daily milk yield has passed through two different phases. In phase 1, from March to May, the gap between the potential milk yield and the effective production reached almost 6 kg of milk per cow per day. Phase 2 occurs from June to July and the gap jumps to almost 12 kg of milk daily (Figure 2).

Table 2 A comparisons of the average lactation potential and the effective milk yield (kg/cow per day)

	Lactating cows	Milk yield (Mean±SD)		Deficit production (P-E)
		Potential (P)	Effective (E)	
Farm 1	14	20.0±0.7	11.6±3.8	8.4
Farm 2	2	22.8±5.8	15.5±1.6	7.3
Farm 3	9	15.1±0.7	13.0±2.1	2.1
Farm 4	3	22.5±3.4	17.2±4.9	5.3
Farm 5	6	23.5±2.8	19.8±5.5	3.7
Farm 6	6	18.5±1.9	15.3±2.3	3.2
Mean	10	20.4±2.5	15.4±3.4	5.0

SD: standard deviation.

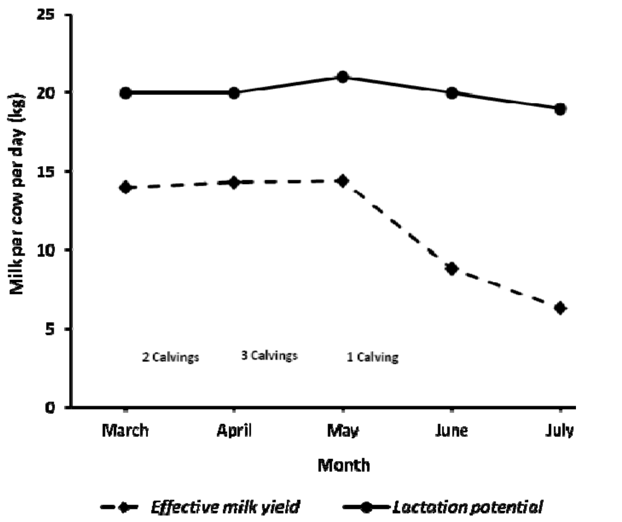

Figure 2 Evolution of the gap between the lactation potential and the effective milk yield in farm 1

The stability of the gap throughout the first phase from March to May is mainly explained by the unbalances in the rations: a marked excess of net energy in comparison to a lack of RDP, because of the nature of the distributed roughage (maize silage) and the use of rice bran, which is mainly energy rich feed (Table 3). Furthermore, the excess energy in comparison to RDP meant that cows had an opportunity for fattening rather than increasing their effective milk yield and that appeared in their average live weight gain which increased by almost 50 kg from May to July (Table 4). From the month of May, because of the decrease in maize silage availability, the farmer has incorporated berseem hay. This feedstuff provided a supply of RDP which allowed maintaining the effective average milk yield at its level in previous months (14 kg per cow per day).

Table 3 Cows' rations and their relationship to the effective milk yield during the study (farm 1)

Month	Milked cows	Potential milk yield (kg/day)	Ration (kg DM/cow per day)	Effective milk yield (kg/day)	Diet balance* Mcal	g proteins
March	12	20.0	Maize silage (9.6) Rice bran (4.6)	14	2.5	-115
April	14	20.0	Maize silage (9.6) Rice bran (5.1)	14	2.7	-103
May	15	21.0	Maize silage (5.9) Berseem hay (3.4) Rice bran (6.2)	14	1.3	79
June	16	20.0	Maize silage (1.8) Berseem hay (2.6) Rice bran (6.2)	9	1.0	141
July	15	19.0	Maize silage (5.3) Wheat straw (5.8)	6	0.1	-279

* Difference between the nutrients' (net energy and protein) content of the ingested ration and the effective requirements for both maintenance and lactation.
DM: dry matter.

However, in the month of June, the decrease of maize silage incorporation could not be covered by berseem hay, and the overall fodders DM ingested by cows dropped to less than 4.5 kg per day. That was almost half the ingested quantity a month before.

Table 4 Average cows' live weight and its variations during the study period in farms 1, 2 and 3 (kg)

	Farm 1	Farm 2	Farm 3
March	548	699	597
April	556	679	569
May	600	645	573
June	616	616	607
July	627	570	553

Therefore, the effective milk yield decreased by almost 5 kg per cow per day (from 14 to 9 kg), even though the potential milk production increased due to 4 calving which occurred in April (3) and May (1). In the month of July, the trend of the effective milk yield decrease persisted, due to the end of berseem hay use and the cessation of rice bran feeding. The only available feedstuffs were maize silage and wheat straw; two low nitrogen content roughages. Therefore, the effective milk yield did not exceed 6 kg per cow per day, at a time where the potential was 19 kg per cow per day. The second type of gap between the average lactation potential and the effective daily milk yield consists in an unstable difference between these two indicators. This was mainly found in farms 2 and 4. In some periods of the year, the effective milk yield was even equal to cow's potential (Figure 3). For example, in farm 2, fresh berseem was distributed from March to May. In the period of abundance of this fodder crop, particularly during the beginning of spring period (until April) the effective milk yield was equal to the cow's milk potential (Table 5). However, in May, the farmer did not change the ration of cows, even though two calvings occurred. As a consequence, a significant gap between the potential milk and the effective yield was observed, as it reached almost 14 kg per day.

In June, the end of fresh berseem availability induced its substitution by berseem hay. Although it was intensively incorporated in the diet, the farmer realized that it would be insufficient to boost cows' milk yield.

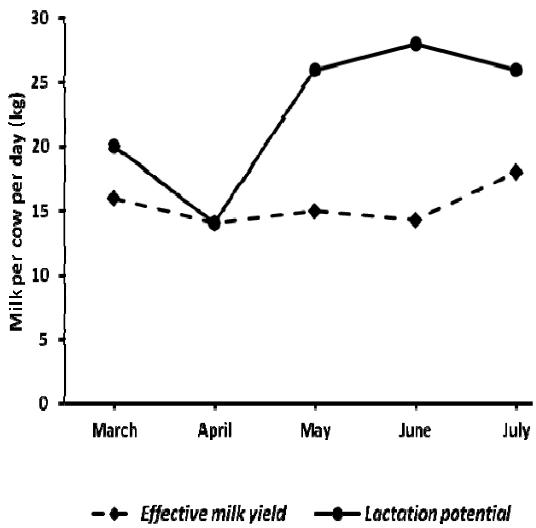

Figure 3 Evolution of the gap between the lactation potential and the effective milk yield in farm 2

Therefore, in July, additional feedstuffs were added, like wheat straw and dried beet pulp. In fact, as the farmer had also noticed a steep decrease in the average cows' live weight-almost 130 kg per cow-(Table 4), he wanted to avoid such a trend and its negative consequences, particularly on cows' fertility.

The third kind of gap between potential and effective cows' milk yields consists in a limited difference between the two indicators during the whole study period. In fact, in farms 3 and 6, the gap did not exceed 2 to 3 kg of milk per cow per day (Figure 4). In both farms, berseem constitutes the main fodder crop. But at the opposite of the farms in the former group, at the end of spring, with the decrease of berseem availability, they rely on alternative fodder crops.

Table 5 Cows' rations and their relationship to the effective milk yield during the study (farm 2)

Month	Milked cows	Potential milk yield (kg/day)	Cows' ration (kg DM/cow per day)	Effective milk yield (kg/day)	Diet balance*	
					Mcal	g proteins
March	1	20	Fresh berseem (2.2) Wheat straw (1.0) Compound feed (4.4) Braley grain (3.1) Wheat bran (1.9)	16	0.0	174
April	1	14	Fresh berseem (4.0) Compound feed (5.0) Wheat bran (2.0)	14	0.1	243
May	2	26	Fresh berseem (4.0) Compound feed (5.0) Wheat bran (2.0)	15	0.7	230
June	3	28	Berseem hay (7.5) Coumpound feed (4.0) Wheat bran (2.0)	14	0.2	301
July	3	26	Berseem hay (7.5) Wheat straw (4.5) Dried beet pulp (1.5) Coumpound feed (2.5) Wheat bran (2.2)	18	0.3	156

* Difference between the nutrients' (net energy and protein) content of the ingested ration and the effective requirements for both maintenance and lactation.
DM: dry matter.

In farm 3, with a potential annual milk yield of only 5000 kg because of a composite genetic structure of the herd, fresh alfalfa is produced and this has allowed maintaining the distributed quantities of fodder DM at a level above 9 kg per cow per day (Table 6).

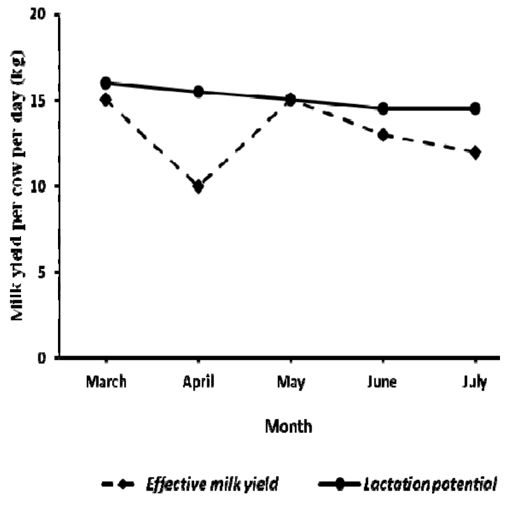

Figure 4 Evolution of the gap between the lactation potential and the effective milk yield in farm 3

Moreover, alfalfa provides enough proteins to meet the optimum requirements of cows, so they can quite reach their potential production. Moreover, the │RDP - MP│/ Mcal ratio remains inferior to 17 throughout the follow-up period, at the exception of the month of June. Such rations' characteristics confirm their equilibrium for an optimal rumen activity, which promotes milk yield.

Further, the average live weight of lactating cows remained quite stable in these farms in comparison to the previous ones, as the supply of nutrients (net energy and proteins) from the rations was near to the overall requirements: maintenance and lactation.

The present study confirms that the evaluation of different herds' milk yield throughout a long period in conventional farms requires a multivariate approach. In fact, it is affected by many factors, such as the herd's genetic merit, its physiological status and its changes (calving, drying up, etc.) and, above all, its rations' characteristics (Broderick, 2003). The study farms' sample shows a limited diversity of fodder crops. This may facilitate the drawing of a precise diagnosis of dairy herds' functioning indicators, like their average milk yield per cow, or concentrates' conversion to milk and the profitability per cow (Srairi *et al.* 2009). The biological cycle of the most common feed crop, i.e. berseem, implies a long period of limited fresh fodder availability; mainly from the beginning of summer, till the mid fall (from June to November). Such a lack of fresh fodder may reduce significantly lactating cows' milk yield, as reported by Garduño-Castro *et al.* (2009), under Mexican smallholder dairy cattle farming conditions. In fact, the same authors suggest that farmers' unique possibility to maintain high levels of milk yield consists in supplementing cows by concentrates, as it has been reported in this study for some of the studied herds.

The average daily level of fodder DM intake per cow during the whole period of the follow-up did not exceed 9.5 kg. This average figure hides an important variability among farms.

Table 6 Cows' rations and their relationship to the effective milk yield during the study (farm 3)

Month	Milked cows	Potential milk yield (kg/day)	Cows' ration (kg DM/cow per day)	Effective milk yield (kg/day)	Diet balance* Mcal	g proteins
March	11	16	Fresh berseem (4.0) Maize silage (3.6) Wheat straw (1.7) Coumpound feed (3.0)	15	0.1	157
April	8	16	Fresh berseem (3.3) Maize silage (3.6) Wheat straw (2.4) Coumpound feed (2.0)	10	0.2	57
May	9	15	Fresh berseem (5.4) Maize silage (3.6) Wheat straw (2.4) Wheat bran (4.8)	15	0.2	100
June	10	14	Alfalfa (7.7) Maize silage (2.8) Coumpound feed (2.2)	13	0.6	469
July	9	14	Alfalfa (7.7) Oat hay (3.1) Dried beet pulp (0.9) Wheat bran (1.7) Coumpound feed (0.9)	12	0.0	357

* Difference between the nutrients' (net energy and protein) content of the ingested ration and the effective requirements for both maintenance and lactation.
DM: dry matter.

It reached only 7.3 kg of DM from fodder per cow daily in farms 1 and 5; farms which illustrate an important and steady gap between the lactation potential of the herd and its effective milk yield. In farms 2 and 4 which illustrate an unstable gap, it averaged 7.4 kg per cow per day. Finally, in the last group of farms (3 and 6), that figure was 10.3 kg of fodder DM ingested per cow per day. In the three groups, the ingested DM per cow seems far from the requirements of cows of about 600 kg of live weight which can reach up to 15 kg for good quality forages, as reported by Castillo *et al*. (2006). Apart from the average quantities, marked differences appear between the three groups. In the first one (farms 1 and 5), the DM from fodder ingested increases notably during the months of May, June and July in comparison to the beginning of spring. This increase is however mainly due to the use of highly lignified and stored dried forages like wheat straw and berseem hay. These forages alone cannot sustain the requirements of high genetic merit cows, particularly at the beginning of their lactation cycle, as their energetic density is too limited (Rabelo *et al*. 2003). Therefore, the effective milk yield did not improve and actually it even decreased, although new calvings occurred. This decrease could be explained by the low intake of nitrogen with regard to the available net energy in rations with lignified forages and inappropriate concentrates supplementation, which would also result on cows' fattening at the expense of milk production (Agnew and Yan, 2000).

In the second group of farms (2 and 4), a similar increase in the DM ingested daily from fodder per cow was noted by the beginning of summer (months of June and July).

But at the opposite of the former situation, a formal supplementation by concentrates (dried beet pulp and compound feed) was observed. This allowed supplying the lactating cows with more nutrients (particularly proteins and also net energy), inducing a decrease in the gap between the herds' lactation potential and its effective milk yield. However, for the specific case of the herd in farm 2, constituted of three purebred Holstein cows, of which two freshly calved, this concentrates supplementation could not avoid a marked loss of body weight. In fact, previous studies have also pointed out that purebred Holstein cows lose more weight than other breeds at the beginning of the lactation cycle, because of their higher milk yields (Dillon *et al*. 2003).

Finally, in group 3 (farms 3 and 6), the forages' DM ingested per cow per day was quite steady throughout the study period as it varied from 9.3 kg in March and April to 11.4 kg in May. Moreover, the end of fresh berseem availability did not impose the use of dried fodder, as the farmers relied on alternative fodder crops, like alfalfa and oat hay. Therefore, the gap between the effective and the potential milk yields remained steady and limited to less than 3 kg per cow per day, during almost the whole period of the follow-up. On the one hand, this could also be explained by the relatively limited genetic merit of this herd (only 5000 kg of milk annually, due to its composite structure with crossbred cows). On another hand, the variations of the average cows' live weight were limited in comparison to the other groups of farms, as the rations allowed supplying nutrients up to their requirements.

The analysis of the composition of the rations' DM content confirms that there are periods of serious lack to feed the cows. Moreover, the qualitative assessment of cows' rations in different herds shows also significant unbalances between energy and protein supply with regard to the changes of their potential requirements. For instance, the lack of protein supply is particularly obvious in the first group of farms (1 and 5), as their main forage supply relies on maize silage. The only month where the farmers have incorporated berseem hay has been characterized by an increase in the RDP supply, but this had no consequence on the average milk yield due to an insufficient supply of energy. In the other farms, at the opposite of the previous situation, the supply of nitrogen was not a limiting factor, due to the use of berseem, either fresh or dried. This leguminous fodder is particularly rich in protein with a low DM content which requires a necessary supplementation by adequate energy rich concentrates to sustain intensive dairy production (Fulkerson *et al*. 2007). This seems not to be respected in all the situations and throughout the study period, particularly in group 2 farms (2 and 4), where the excess of RDP reaches up to 300 g per cow per day, because of an inadequate supplementation in energy rich concentrates. This not only impairs the effective milk yield per cow (less than 15 kg per cow per day at a time where the potential is at 26 kg), but it also generates a situation of harmful waste of nitrogen. In fact, the $|$RDP - MP$|$ / Mcal ratio remains critically superior to a value above 17, which may be negative for the rumen environment, as it generates ammonia N levels above microorganisms' requirements (Melendez *et al*. 2003). Moreover, such an unbalance between energy and RDP supply in the ration implies an increase in plasma urea concentration, which may impair the herd's reproductive performances (Lean *et al*. 2012), particularly because it creates unfavorable conditions for the embryo viability (Mc Cormick *et al*. 1999).

Altogether, these results imply that on conventional dairy farms in Morocco, numerous setbacks characterize their effective performances. The most obvious figure is that in many farms, the choice of high genetic merit dairy cows is not systematically joined to a corresponding adapted feeding system. That is particularly evident during the summer period, when the availability of high quality forages drops, and when their substitution by dried and lignified forages is not systematically associated to sound concentrate supplementation. The consequences on the effective milk yield may be dramatic, and that might even be worsened if the herds' potential increases because of calvings occurring during late spring or the beginning of summer. The consequences on the herd profitability are immediately negative, as the milk output often does not allow covering the feed expenses associated to cows of a live weight greater than 500 kg. To some extent, such negative impacts of inappropriate feeding practices may induce higher culling rates of imported cows (Srairi and Baqasse, 2000), which aggravates the economic losses of the dairy farms.

Using a similar analysis, Moran (2013) confirms that under tropical Asian conditions, the average milk yield of a cow can be a good tool to assess the whole dairy farm management practices. This author estimates that additional efforts have to be made to promote the effective milk yield per cow, particularly ensuring a sufficient DM supply from good quality forages throughout the year. Therefore, support programs are requested to demonstrate effectively to farmers the possibilities to increase the herd's milk yield and improve its long term profitability, as it has been reported in other areas of Morocco (Srairi *et al*. 2011).

CONCLUSION

This study confirms the close relationship between lactating cows' effective milk yield and the nutrients content (net energy, RDP and MP) of their rations. In fact, the study protocol has first allowed assessing the changes in the lactation potential, as a result of the evolutions in the reproduction status of the cows. Second, the variations in the availability of nutrients in lactating cows' rations have been determined throughout the five-month study period. The results showed that the highest daily milk yields are explained mainly by the availability of high quality forage in sufficient amounts correctly supplemented by adequate concentrates. At the opposite, the average milk yield per cow fell by more than 50% in farms where green fodder is substituted by lignified roughage like wheat straw or berseem hay, particularly in the summer period. The assessment of the rations' balance between net energy, RDP and MP showed frequent feed formulation errors. As berseem is widely used until the end of May, an excess of RDP is often noted, which means a waste of feed proteins not converted to milk because of a lack of net energy. As a consequence, reproductive failures may occur, though this aspect of the dairy herd management was not assessed during this study. Therefore, it seems that farmers do not feed their cows according to their lactating potentials. Moreover, favorable periods of potential high milk yields (because of a succession of calvings) are not successively exploited on many farms because of inadequate feeding practices, implying significant economic losses. Altogether, these results imply that urgent support programs to promote the dairy development are needed. Above all, on-farm long term feed trials are requested to demonstrate to farmers the possibilities to enhance the herd's milk output and to improve its profitability. That might be a compulsory condition to implement a sustainable dairy development mainly based on smallholder units, which remain in many parts of the world, as in Morocco, major actors in the dairy supply chains.

ACKNOWLEDGEMENT

This research was carried out in the framework of the Crop Livestock Integration in the MEDiterranean project (CLIMED). The authors wish to thank the National Association of Cattle Breeders-Morocco-(ANEB) for its support during the field work. The authors would also like to thank the farmers for collaborating in the study of their practices, as well as the anonymous reviewers for their helpful comments.

REFERENCES

ADA. (2011). Agence pour le Developpement Agricole. The dairy chain development in Morocco. http://www.ada.gov.ma/filiere_par_regions/region_gharb_chrarda_bni_hssen/filiere_lait.php Accessed Dec. 2013.

Agnew R.E. and Yan T. (2000). Impact of recent research on energy feeding systems for dairy cattle. *Livest. Prod. Sci*. **66,** 197-215.

Bernard J., Le Gal P.Y., Triomphe B., Hostiou N. and Moulin C.H. (2011). Involvement of small-scale dairy farms in an industrial supply chain: when production standards meet farm diversity. *Animal*. **5,** 961-971.

Broderick G.A. (2003). Effect of varying dietary protein and energy levels on the production of lactating dairy cows. *J. Dairy Sci*. **86,** 1370-1381.

Castillo A.R., Taverna A.M., Páez R.R., Cuatrin A., Colombatto D., Bargo F., García M.S., García P.T., Chavez M., Beaulieu A.D. and Drackley J.K. (2006). Fatty acid composition of milk from dairy cows fed fresh alfalfa based diets. *Anim. Feed Sci. Technol.* **131,** 241-254.

Dillon P., Buckley F., O'Connor P., Hegarty D. and Rath M. (2003). A comparison of different dairy cow breeds on a seasonal grass-based system of milk production: 1. Milk production, live weight, body condition score and DM intake. *Livest. Prod. Sci.* **83,** 21-33.

Faysse N., Srairi M.T. and Errahj M. (2012). Local farmers' organisations: a space for peer-to-peer learning? The case of milk collection cooperatives in Morocco. *J. Agric. Educ. Extension.* **18,** 285-299.

Fulkerson W.J., Neal J.S., Clark C.F., Horadagoda C.F., Nandra K.S. and Barchi I. (2007). Nutritive value of forage species grown in the warm temperate climate of Australia for dairy cows: grasses and legumes. *Livest. Sci.* **107,** 253-264.

Garduño-Castro Y., Espinoza-Ortega A., González-Esquivel C.E., Mateo-Salazar B. and Arriaga-Jordán C.M. (2009). Intercropped oats (*Avena sativa*) common vetch (*Vicia sativa*) silage in the dry season for small-scale dairy systems in the highlands of central Mexico. *Trop. Anim. Health Prod.* **41,** 827-835.

Guessous F. (1991). Production Fourragère et Systèmes Animaux. Institut Agronomique et Veterinaire Hassan II, Rabat, Morocco.

Heinrichs A.J., Erb H.N., Rogers G.W., Cooper J.B. and Jones C.M. (2007). Variability in Holstein heifer heart-girth measurements and comparison of prediction equations for live weight. *Prev. Vet. Med.* **78,** 333-338.

ICAR. (2011). International Committee for Animal Recording. International agreement for recording practices. Riga, Latvia. http://www.icar.org/Documents/Rules%20and%20regulations/Guidelines/Guidelines_2011.pdf Accessed Dec. 2013.

Jarrige R. (1988). Table des valeurs nutritionnelles des aliments. Pp. 351-443 in Alimentation des Bovins, Ovins et Caprins. R. Jarrige, Ed. Paris, France.

Kidd A.D., Lamers J.P.A., Ficarelli P.P. and Hoffman V. (2000). Privatising agricultural extension: *caveat emptor*. *J. Rural Stud.* **16,** 95-102.

Le Gal P.Y., Kuper M., Moulin C.H., Srairi M.T. and Rhouma A. (2009). Linking water saving and productivity to agro-food supply chains: a synthesis from two north African cases. *Irrigation. Drainage.* **58,** 320-333.

Lean I.J., Celi P., Raadsma H., Mc Namara J. and Rabiee A.R. (2012). Effects of dietary crude protein on fertility: meta-analysis and meta-regression. *Anim. Feed Sci. Technol.* **171,** 31-42.

Martin R.C., Astatkie T., Cooper J.M. and Fredeen A.H. (2005). A comparison of methods used to determine biomass on naturalized swards. *J. Agron. Crop Sci.* **191,** 152-160.

Mc Cormick M.E., French D.D., Brown T.F., Cuomo G.J., Chapa A.M., Fernandez J.M., Beatty J.F. and Blouin D.C. (1999). Crude protein and rumen undegradable protein effects on reproduction and lactation performance of Holstein cows. *J. Dairy Sci*. **82,** 2697-2708.

Mc Dermott J.J., Staal S.J., Freeman H.A., Herero M. and Van de Steeg J.A. (2010). Sustaining intensification of smallholder livestock systems in the tropics. *Livest. Sci.* **101,** 95-109.

Melendez P., Donovan A., Hernandez J., Bartolome J., Risco C.A., Staples C. and Thatcher W.W. (2003). Milk, plasma and blood urea nitrogen concentrations, dietary protein and fertility in dairy cattle. *J. Am. Vet. Med. Assoc.* **223,** 628-634.

Moran J.B. (2013). Addressing the key constraints to increasing milk production from small holder dairy farms in tropical Asia. *Int. J. Agric. Biosci*. **2,** 90-98.

Rabelo E., Rezende R.L., Bertics S.J. and Grummer R.R. (2003). Effects of transition diets varying in dietary energy density on lactation performance and ruminal parameters of dairy cows. *J. Dairy Sci*. **86,** 916-925.

Srairi M.T. and Baqasse M. (2000). Production and reproduction performance of imported Friesian dairy heifers in Morocco. *Livest. Res. Rural Dev.* http://www.lrrd.org/lrrd12/3/sra123.htm Accessed Dec. 2013.

Srairi M.T. and El Khattabi M. (2001). Evaluation économique et technique de la production laitière intensive en zone semi-aride au Maroc. *Cah. Agric.* **10,** 51-56.

Srairi M.T., El Jaouhari M., Saydi A., Kuper M. and Le Gal P.Y. (2011). Supporting small scale dairy farmers increasing their milk production: evidence from Morocco. *Trop. Anim. Health*

Prod. **43,** 41-49.

Srairi M.T., Kiade N., Lyoubi R., Messad S. and Faye B. (2009). A comparison of dairy cattle systems in an irrigated perimeter and in a suburban region: case study from Morocco. *Trop. Anim. Health Prod.* **41,** 835-843.

Srairi M.T., Leblond J.M. and Bourbouze A. (2003). Dairy and / or beef production: diversity of cattle farmers' strategies in Gharb irrigated area, northern Morocco. *Rev. Elev. Med. Vet. Pays. Trop.* **56,** 177-186.

Verite R. and Peyraud J.L. (1988). Nutrition azotee. Pp. 75-93 in Alimentation des Bovins, Ovins et Caprins. R. Jarrige, Ed. Paris, France.

Wanapat M. (2009). Potential uses of local feed resources for ruminants. *Trop. Anim. Health Prod*. **41,** 1035-1049.

Wilmink J.B.M. (1987). Adjustment of test-day milk, fat and protein yield for age, season and stage of lactation. *Livest. Prod. Sci.* **16,** 335-348.